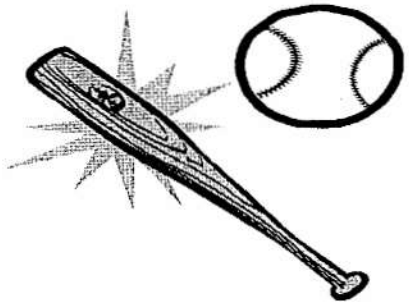
Model: Collision Theory

In the picture below, the baseball bat represents **Reactant A** and the baseball represents **Reactant B**. A reaction will only be successful if the batter hits a homerun. If the batter does not hit a homerun, the reaction will be considered a failure. Now, read the four scenarios below and answer the key questions that follow.



Scenario 1: The pitcher throws a fastball down the middle of the plate. The batter takes a mighty swing and totally misses the ball. The umpire yells, "Strike one!"

Scenario 2: The pitcher throws an off-speed pitch and the batter checks his swing. The batter just barely makes contact with the ball and it dribbles down in front of the batter's feet into foul territory. The umpire yells, "Foul ball; strike two!"

Scenario 3: The pitcher throws a curve ball that looks like it might catch the outside corner of the plate. The batter swings with all his strength, but the bat grazes the underside of the ball and the ball skews off to the right, flying into the crowd. The umpire yells, "Foul ball, still two strikes!"

Scenario 4: The pitcher throws another fastball down the middle of the plate. The batter swings and wallops the ball high into the air and the ball clears the center field wall that reads 410 feet. The ump yells, "Homerun!"

Authored by: Bryan Horan; Revised by: Kelly Levy and Kenneth Levy
Edited by Linda Padwa and David Hanson, Stony Brook University

40

Key Questions

1. Did a reaction take place between **Reactant A** and **Reactant B** in Scenario 1? Why or why not? Explain your reasoning in terms of the *nature* of the collision.

No, no collision occurred so no reaction

2. Did a reaction take place between **Reactant A** and **Reactant B** in Scenario 2? Why or why not? Explain your reasoning in terms of the *nature* of the collision.

No reaction since there was not enough energy

3. Did a reaction take place between **Reactant A** and **Reactant B** in Scenario 3? Why or why not? Explain your reasoning in terms of the *nature* of the collision.

No reaction since orientation was not correct

4. Did a reaction take place between **Reactant A** and **Reactant B** in Scenario 4? Why or why not? Explain your reasoning in terms of the nature of the collision.

Yes, b/c correct orientation + enough energy

5. Based on your responses to Key Questions 1-4 and your reasoning, what insight has your team gained about the term effective collision?

need enough energy & correct orientation

6. Based on your answer to Key Question 5, complete the following statement: Collision theory states that a reaction is most likely to occur if...

Reactants have enough energy & correct orientation

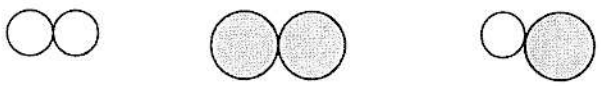
Authored by: Bryan Horan; Revised by: Kelly Levy and Kenneth Levy
Edited by Linda Padwa and David Hanson, Stony Brook University

Answers on this page ~~should~~ can vary

7. With your group, develop a different analogy/model to explain the collision theory to someone who is not in your group.

Exercise

1. Hydrogen gas and iodine vapor combine to form hydrogen iodide gas, as shown in the equation $H_2 + I_2 \rightarrow 2\ HI$. Using the representations shown below, draw a diagram to show an orientation for the reactant molecules that could produce an effective collision capable of producing two hydrogen iodide molecules.



H_2 I_2 HI

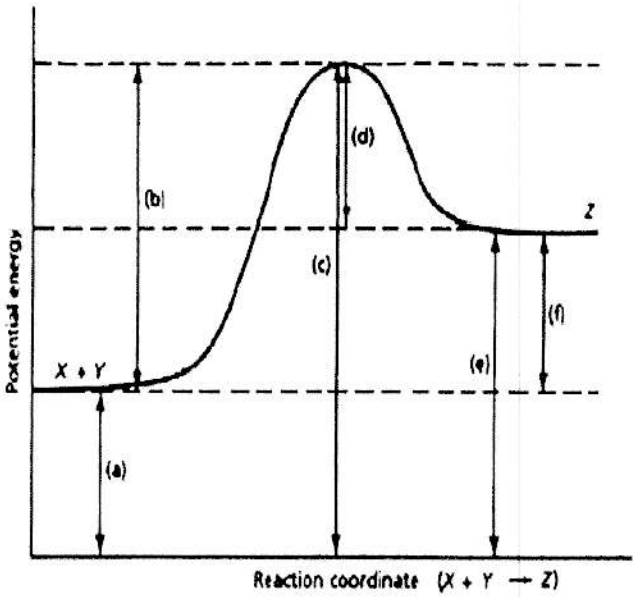
2. Using the representations shown in question 1, draw a diagram to show an orientation for the reactant molecules that would NOT produce an effective collision.

Authored by: Bryan Horan; Revised by: Kelly Levy and Kenneth Levy
Edited by Linda Padwa and David Hanson, Stony Brook University

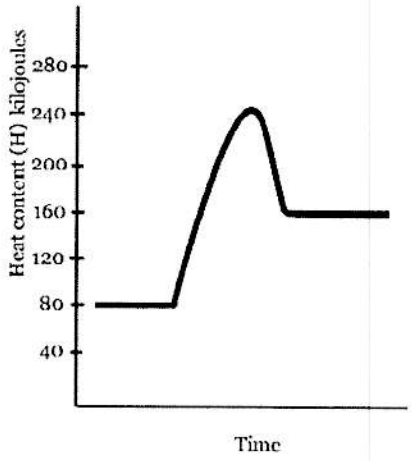
Honors Chemistry Classwork: Equilibrium

Potential Energy Diagrams

1. Which of the letters a–f in the diagram represents the potential energy of the products? e
2. Which letter indicates the potential energy of the activated complex? b
3. Which letter indicates the potential energy of the reactants? a
4. Which letter indicates the activation energy? b
5. Which letter indicates the heat of reaction? f
6. Is the reaction exothermic or endothermic? endo
7. Which letter indicates the activation energy of the reverse reaction? d
8. Which letter indicates the heat of reaction of the reverse reaction? f
9. Is the reverse reaction exothermic or endothermic? exo



1. The heat content of the reactants of the forward reaction is about 80 kilojoules.
2. The heat content of the products of the forward reaction is about 160 kilojoules.
3. The heat content of the activated complex of the forward reaction is about 240 kilojoules.
4. The activation energy of the forward reaction is about 160 kilojoules. 240 − 80
5. The heat of reaction (ΔH) of the forward reaction is about 80 kilojoules. 160 − 80
6. The forward reaction is endo (endothermic or exothermic).
7. The heat content of the reactants of the reverse reaction is about 160 kilojoules.
8. The heat content of the products of the reverse reaction is about 80 kilojoules.
9. The heat content of the activated complex of the reverse reaction is about 240 kilojoules.
10. The activation energy of the reverse reaction is about 80 kilojoules. 240 − 160
11. The heat of reaction (ΔH) of the reverse reaction is about −80 kilojoules.
12. The reverse reaction is exo (endothermic or exothermic).



Collision Theory

1. Chemical reactions occur when reactants collide. For what reasons may a collision fail to produce a chemical reaction? not enough energy &
not correct orientation

2. If every collision between reactants lead to a reaction, what determines the rate at which the reaction occurs?
# of collisions in a given amount of time
more collisions / sec = a faster reaction

3. What is the activation energy of a reaction, and how is this energy related to the activated complex of the reaction?
energy needed reactants need to collide effectively
A.E. is the additional energy that make the total energy of the activated complex.

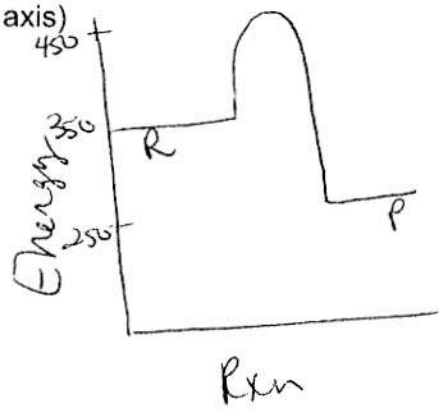
4. What happens when a catalyst is used in a reaction?
lowers the activation energy

5. Name 4 things that will speed up or slow down a chemical reaction.

Speed up
a) increase conc
b) add catalyst
c) increase temp
d) increase surface area

Slow down
a) ↓ conc
b) add inhibitor
c) ↓ temp
d) ↓ S.A.

6. Draw an energy diagram for a reaction. (label the axis)
Potential energy of reactants = 350 KJ/mole
Activation energy = 100 KJ/mole
Potential energy of products = 250 KJ/mole



7. Is the reaction in # 6 exothermic or endothermic? Explain.
exothermic P have less energy than R.

8. How could you lower the activation energy for the reaction in #6?
add a catalyst

8. How could you lower the activation energy for the reaction in #6? add a catalyst

Equilibrium Expressions You have the answers already!

1. Calculate the equilibrium concentration of HI for the reaction: $2HI = H_2 + I_2$ if Keq = 0.0186 and if the equilibrium concentrations are $[H_2] = 0.00290$ and $[I_2] = 0.0017$ (Ans: 0.0163 M)

2. Calculate the equilibrium concentrations at 400°C of NH_3 for the reaction: $N_2 + 3H_2 = 2NH_3$. The equilibrium concentrations for the reactants at 400°C are $[N_2] = 0.45$ M and $[H_2] = 1.10$ M. The Keq at this temperature is 0.0017. (Ans: $[NH_3] = 0.032$M)

3. For the following equilibrium reaction: $N_2O_4 = 2NO_2$, a 3 liter flask at equilibrium is found to contain 10.8 moles of N_2O_4 and 5.25 moles of NO_2. Calculate Keq. (Ans: Keq = 0.85)

4. At a given temperature, the K_{eq} for the reaction $2HI(g) \rightarrow H_2(g) + I_2(g)$ is 1.40×10^{-2}. If the concentration of both H_2 and I_2 at equilibrium are 2.00×10^{-4}M, find the concentration of HI.

(Ans: 0.00169M)

5. Acetic acid dissociates in water. If $K_{eq} = 1.80 \times 10^{-5}$ and the equilibrium concentrations of acetic acid is 0.09986M, what is the concentration of $H^+(aq)$ and $C_2H_3O_2^-(aq)$?

(Ans:0.00134M)

$HC_2H_3O_2(aq) \rightarrow H^+(aq) + C_2H_3O_2^-(aq)$

6. At 60.2°C the equilibrium constant for the reaction $N_2O_4(g) \rightarrow 2NO_2(g)$ is 8.75×10^{-2}. At equilibrium at this temperature a vessel contains N_2O_4 at a concentration of 1.72×10^{-2}M. What concentration of NO_2 does it contain?

(Ans: 0.0388M)

7. At equilibrium, K for the decomposition of HI(g) was found to be 1.07×10^{-5}. The equilibrium concentration of HI(g) was found to be 0.129M. Calculate the concentration of I_2 at equilibrium.
(Hint - Let x = the concentration of I_2. What would the concentration of H_2 be if x is the concentration of I_2? Refer to the coefficients of the equation to help you.)

$2HI(g) \rightarrow H_2(g) + I_2(g)$

(Ans: 0.000422M)

8. In each problem, calculate the missing concentration or constant at equilibrium.

	[HI]	$[H_2]$	$[I_2]$	K_{eq}	
8.	1.78	0.172	0.172	X	(Ans: 0.00934)
9.	X	0.242	0.242	0.217	(Ans: 0.519)
10.	0.78	0.112	X	2.06×10^{-2}	(Ans: 0.112)

MODEL 1: Dynamic Equilibrium

Acme Manufacturing has been restricted to 100 employees in the building at one time. Throughout the day, twenty employees go on break each hour as twenty other employees return from break.

Chemical Equilibrium

$$2H_2(g) + O_2(g) \leftrightarrow 2H_2O(g) + \text{energy (heat)}$$

Questions

1. How many employees move in and out of the factory building during each hour?

40

2. Are the employees who move in and out of the building each hour the same people? Explain your answer.

NO

3. Does the number of employees in the building change from hour to hour? Explain your answer.

NO

4. Over the course of a day, the employees in the Acme Manufacturing Plant are said to be in a "dynamic equilibrium", Based on your understanding of how the staff move in and out of the plant, explain what is meant by the term "dynamic equilibrium".

yes, they are constantly changing @ the same rate

Authored by M. Chiolo; Revised by E. Graham, L. Giloni and Ellen Kannengieser
Edited by Linda Padwa and David Hanson, Stony Brook University

5. A new faster and simpler check-in/check-out process has been proposed for workers at the Acme Manufacturing Plant. Some workers have said that this new process acts like a catalyst. (A catalyst is a substance that speeds up a chemical reaction without changing the outcome of the reaction and without being used up in the process.)
   a. Would this new check-in/check-out process change the number of people in the building at any given time? Why or why not?

      No, same # move in & out

   b. What would be the effect of the new check-in/check-out process on the workers at the factory?

      move in + out faster

   c. Support or refute the idea that the new check-in/check-out process is like a catalyst.

      move faster but doesn't interfere w/ # of employees.

Like the Acme Manufacturing Plant, chemical reactions can also reach equilibrium. Answer the following questions about the chemical equation in Model 1 by applying the insight you gained from the Acme Manufacturing Plant questions.

6. When the reaction between hydrogen and oxygen **reaches equilibrium**:
   a. Does the number of molecules in the reaction vessel change? Explain.

      No

   b. Is the reaction still proceeding in the forward direction?

      Yes

   c. Is the reaction still proceeding in the reverse direction?

      Yes

   d. Are the concentrations of the products and reactants changing?

      Yes

   e. Are the rates of the forward and reverse reactions the same?

      Yes

   f. Does the heat content of the system become constant?

      Yes

Authored by M. Chiolo; Revised by E. Graham, L. Giloni and Ellen Kannengieser
Edited by Linda Padwa and David Hanson, Stony Brook University

42 50

MODEL 2: LE CHATELIER'S PRINCIPLE

Reactant: Increase (↑) causes the equilibrium to shift to the right (→)
Decrease (↓) causes the equilibrium to shift to the left (←)

Product: Increase (↑) causes the equilibrium to shift to the left (←)
Decrease (↓) causes the equilibrium to shift to the right (→)

Temperature: A change in temperature corresponds to a change in energy therefore by using the 'energy' term in the equation itself, it can be treated like a reactant or product (see above).

Pressure: An increase (↑) in pressure causes the equilibrium to shift towards the "smaller number of moles *of gas*" side.
A decrease (↓) in pressure causes the equilibrium to shift towards the "larger number of moles *of gas*" side.
Note: If the number of moles of gas is the same on both sides, then a change in pressure has no effect in the equilibrium.

The following equation describes a system that is at equilibrium:

$$2H_2\,(g) + O_2\,(g) \leftrightarrow 2H_2O\,(g) + \text{energy (heat)}$$

In Table 1 apply Le Chatelier's Principle and indicate the direction of the shift in equilibrium if the indicated stress is applied to the reaction system. (The first one is completed for you.)

Key Questions

1. Complete the following table:

Stress	Shift Direction
Concentration H_2 increases	→ shifts to the right
Concentration H_2 decreases	←
Concentration of O_2 increases	→
Concentration of O_2 decreases	←
Concentration of H_2O increases	←
Concentration of H_2O decreases	→
Temperature increases	←
Temperature decreases	→
Pressure increases least moles gas	→
Pressure decreases	←

Authored by M. Chiolo; Revised by E. Graham, L. Giloni and Ellen Kannengieser
Edited by Linda Padwa and David Hanson, Stony Brook University

The following questions are based on the table in Question #1

2. In general terms, describe the direction of the equilibrium shift when the concentration of a reactant is increased. →

3. If an equilibrium shifts to the right, which reaction speeds up, the forward or the reverse?
reverse

4. What happens to the concentrations of the reactants H_2 and O_2 when the reaction in Model 2 shifts to the right? ↓

5. What happens to the concentration of the product H_2O when the reaction in Model 2 shifts to the right? ↑

6. If an equilibrium shifts to the left, which reaction speeds up, the forward or the reverse?
forward

7. What happens to the concentrations of the reactants H_2 and O_2 when the reaction in Model 2 shifts to the left? ↑

8. What happens to the concentration of the product H_2O when the reaction in Model 2 shifts to the left? ↓

9. What is true of the reaction rates for the forward and reverse reactions when a new equilibrium is established?
equal

Got It!

Write a general description based on the information in Table 1 that describes what happens to an equilibrium system when conditions change.

Amounts of products & reactants change until a new equilibrium position is achieved.

Authored by M. Chiolo; Revised by E. Graham, L. Giloni and Ellen Kannengieser
Edited by Linda Padwa and David Hanson, Stony Brook University

44 52

EXERCISES:

1. Fill in the blanks in the chart below, given the reaction to form nitrogen oxide in a container.

$$N_2\,(g) + O_2\,(g) + \text{heat} \Leftrightarrow 2\,NO\,(g)$$

	Stress	Shift (right/left)	Amount (increases/decreases)
1.	N_2 added	right	of NO increases
2.	O_2 removed	left	of N_2 increase
3.	NO removed	right	of N_2 decreases
4.	Heat added	right	of NO increases

PROBLEMS:

The production of ammonia gas from its gaseous elements (with the release of heat) is a common industrial reaction known as the Haber Process. In order to maximize the yield of ammonia gas in the shortest amount of time, Le Chatelier's Principle is used to guide the conditions used by manufacturers when making ammonia.

1. Write the complete balanced chemical reaction for the Haber Process (include heat in the reaction equation.)

$N_2 + 3H_2 \rightleftharpoons 2NH_3 + \text{heat}$

2. Create a chart similar to Table 1 that lists the possible stresses, the resulting direction of equilibrium shift, and the impact on the chemical concentrations of the reactants and products for this reaction.

Stress	Shift	Amount
add N_2	→	↑ NH_3
remove N_2	←	↓ NH_3
add H_2	→	↑ NH_3
remove H_2	←	↓ NH_3
add NH_3	←	↑ H_2
remove NH_3	→	↓ H_2
add heat	←	↑ N_2
remove heat	→	↓ N_2

LeChatelier's Principle

1. What is Le Chatelier's Principle?

Complete the following charts by writing →, ←, or none for "shift" & increase, decrease or stay the same for the concentrations of reactants and products.

Reaction: $N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g) + 100.4\ kJ$ after change

Stress	Equilibrium Shift	[nitrogen]	[hydrogen]	[Ammonia]
Add nitrogen	→	↑	↓	↑
Add hydrogen	→	↓	↑	↑
Add ammonia	←	↑	↑	↑
Remove nitrogen	←	↓	↑	↓
Remove hydrogen	←	↑	↓	↓
Remove ammonia	→	↓	↓	↓
Increase temperature	←	↑	↑	↓
Decrease temperature	→	↓	↓	↑
Increase pressure	→	↓	↓	↓
Decrease pressure	←	↑	↑	↓
Add catalyst	—	—	—	—

Reaction: $NaOH(s) \leftrightarrow Na^+(aq) + OH^-(aq) + 10.6\ kJ$ **remember pure (s) & (l) do not affect equilibrium values**

Stress	Equilibrium Shift	Amount NaOH (s)	[Na^+]	[OH^-]	K
Add NaOH (s)	—	↑	—	—	—
Add NaCl (adds Na ions)	←	↑	↑	↓	—
Add KOH (adds OH ions)	←	↑	↓	↑	—
Increase temperature	←	↑	↓	↓	↓
Decrease temperature	→	↓	↑	↑	↑
Increase P	—	—	—	—	—
Decrease P	—	—	—	—	—

ICE Charts in Equilibrium Expressions

1. 1.60 moles of W and 2.4 moles of X react slowly in a 2 liter container to produce U and V according to the following equation: 2W + 3 X = U + 2V. At equilibrium, 0.50 mole of U is present. Calculate Keq. (Ans: Keq=7.6)

	$2W$	$+ 3X \rightleftharpoons$	U	$+ 2V$
I	0.8M	1.2M	0	0
C	-0.5	-0.75	+0.25	+0.5
E	0.3	0.45	0.25M	0.5

$$K = \frac{(0.25)(0.5)^2}{(0.3)^2(0.45)^3}$$

$K = 1.6$

2. Given: A + 2B = 3C + D. 5.0 moles of A and 6.0 moles of B are originally placed in a 10 liter container. At equilibrium only 3 moles of B are left. Calculate Keq. (Ans: 0.43)

	A	$+ 2B \rightleftharpoons$	$3C$	$+ D$
I	0.5	0.6	0	0
C	-0.15	-0.3	+0.45	+0.15
E	0.35	0.3	0.45	0.15

$$K = \frac{(0.45)^3(0.15)}{(0.35)(0.3)^2}$$

$K = 0.43$

3. The reaction: A = 2C + B takes place in a 2.0 liter container. 7.5 moles of A are originally placed in the container and at equilibrium 3.0 moles of C have been produced. Calculate Keq (Ans:0.56)

	A	⇌	2C	+	B
I	3.75		0		0
C	-0.75		1.5		0.75
E	3.00		1.5		0.75

$$K = \frac{(1.5)^2 (0.75)}{3} = 0.56$$

4. We place 0.064 mol N_2O_4 (g) in a 4.00 L flask at 200K. After reaching equilibrium, the concentration of NO_2 (g) is 0.0030 M. What is K for the reaction: $N_2O_{4\,(g)} \leftrightarrow NO_{2\,(g)}$ (Ans: 1.6x10^{-4})

6.2 x 10^{-4}

	N_2O_4	⇌	$2NO_2$
I	0.016		0
C	-0.0015		0.0030
E	0.0145		0.0030

$$\frac{(0.003)^2}{0.0145}$$

56

Equilibrium ICE Chart Practice Problems Set #2

1. For the combination reaction: H_2 (g) + I_2 (g) ⇆ 2 HI (g), calculate all three equilibrium concentrations when $[H_2]_o = [I_2]_o = 0.200$ M and $K_c = 64.0$.

$$\sqrt{64} = \sqrt{\frac{(2x)^2}{(0.2-x)^2}}$$

$$8 = \frac{2x}{0.2-x}$$

$$1.6 - 8x = 2x$$

$$1.6 = 10x$$

$$0.16 = x$$

$[HI] = 0.32\,M$

$[H_2] = [I_2] = 0.04M$

2. For the decomposition reaction, $HC_2H_3O_2$ (aq) ⇆ H^+ (aq) + $C_2H_3O_2^-$ (aq), calculate all three equilibrium concentrations when $K_c = 1.8\times10^{-5}$ with $[HC_2H_3O_2]_o = 0.500$M. (because weak acids do not dissociate very much their equilibrium concentration is considered to be equal to their original concentration)

$$1.8\times10^{-5} = \frac{x^2}{0.5}$$

$$x = 0.003M$$

$[HC_2H_3O_2] = 0.500M$

$[H^+] = [C_2H_3O_2^-] = 0.003M$

3. We place 0.064 mol HF in a 4.00 L flask at 200 K. After reaching equilibrium, what are all 3 equilibrium concentrations if the K= 3.2×10^{-9} for the reaction HF(g) ⇆ H^+ (aq) + F^- (aq) at 200K? (HF is a weak acid)

$$3.2\times10^{-9} = \frac{x^2}{0.016}$$

$x = 7.2\times10^{-6}M$

$[HF] = 0.016M$

$[H^+] = [F^-] = 7.2\times10^{-6}M$

4. Chlorous acid dissociates: $HClO_2$ ⇆ H^+ (aq) + ClO_2^- (aq) with a K=1.1×10^{-2} at 25°C. If an initial concentration of 0.330 M $HClO_2$ is allowed to equilibrate, what are all 3 equilibrium concentrations? (weak acid)

$$1.1\times10^{-2} = \frac{x^2}{0.330}$$

$x = 0.0602M = [H^+] = [ClO_2^-]$

$[HClO_2] = 0.330M$

Honors Chemistry Exam Review #1 Name: Nicksic

Essential Standard 1.3: Understand the physical and chemical properties of atoms based on their position on the Periodic Table.

1. The rows on the periodic table are called Periods/energy levels. The columns on the periodic table are called groups.

2. Fill in the table below:

Group	Name	Valence Electrons	Charge (oxidation state)
IA 1	Alkali Metals	1	+1
IIA 2	Alkali Earth Metals	2	+2
VIIA 7	Halogens	7	-1
VIIIA 8	Noble gases	8	0
B d block	Transition Metals	Varies (most have at least 2)	varies

3. Reactivity of metals (decreases/(increases)) down the group, but reactivity for nonmetals ((decreases)/increases) down the group. Therefore the most active metal is Fr and the most active nonmetal is F.

4. Metals are on the Left side of the periodic table. Nonmetals are on the right side of the periodic table. Metalloids are along the staircase.

5. Classify the following elements as either a metal, nonmetal, or metalloid.

a. Fe Metal b. Si Metalloid c. Ar Non metal

d. Ca Metal e. U Metal f. O Nonmetal

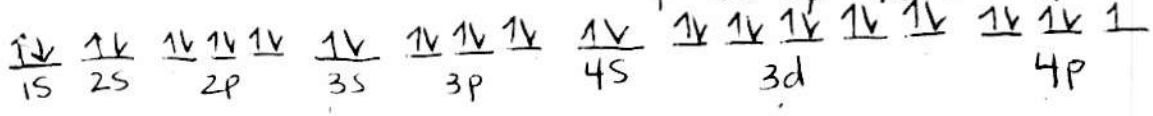
6. The atomic radius increases down a group and decreases across a period. ↓ ←

7. Cations are smaller than their respective neutral atom. Anions are larger than their respective neutral atom.

8. The ionization energy decreases down a group and increases across a period. →↑

9. The electronegativity decreases down a group and increases across a period. →↑

10. Write the orbital notation for Bromine. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^5$



11. How many valence electrons do the following have?

a. $1s^2 2s^2 2p^6 \underline{3s^1}$ 1 b. $1s^2 2s^2 2p^6 3s^2 3p^6 \underline{4s^2} 3d^4$ 2

12. How many electrons would you expect the following to lose or gain. (for example gain 2, or lose 1)

a. $1s^2 2s^2 2p^4$ gain 2 b. $1s^2 2s^2 2p^6 3s^2 3p^6 \underline{4s^2} 3d^4$ lose 2

13. What would be the charge (oxidation state) for the following?

a. $1s^2 2s^2 2p^6 \underline{3s^1}$ +1 b. $1s^2 2s^2 2p^6 3s^2 3p^6 \underline{4s^2} 3d^4$ +2

14. Put the following groups of elements in increasing order of ionization energy →↑

a. C, Fe, Fr Fr, Fe, C b. Xe, Co, Na Xe, ~~Na~~ Co, ~~Co~~ Na, Xe

16. Put the following groups of elements in decreasing order of electronegativity. →↑

a. C, Fe, Fr C, Fe, Fr b. Xe, Co, Na Na, Co, Xe

[redacted]ors Chemistry Exam Review #2 Name: Nicksic

[redacted]ssential Standard 1.2: Understand the bonding that occurs in simple compounds in terms of bond type, strength, and properties.

1. Identify the following statements as ionic, covalent, or metallic.

a. Sea of electrons	ionic	covalent	(metallic)
b. Formed by a metal and a nonmetal	(ionic)	covalent	metallic
c. Formed by nonmetals only	ionic	(covalent)	metallic
d. Conducts electricity as a solid	ionic	covalent	(metallic)
e. Poor conductor of electricity	ionic	(covalent)	metallic
f. Can be solid, liquid, or gas at room temperature	ionic	(covalent)	metallic
g. Forms crystalline solids	(ionic)	covalent	metallic
h. Have high melting points	(ionic)	covalent	metallic
i. Have low boiling points	ionic	(covalent)	metallic
j. Have high electrical conductivity in molten state	(ionic)	covalent	metallic
k. Have high electrical conductivity in aqueous solution	(ionic)	covalent	metallic
l. Are ductile	(ionic)	covalent	(metallic)
m. Have low melting points	ionic	(covalent)	metallic
n. Have luster	(ionic)	covalent	(metallic)
o. Forms through a transfer of electrons	(ionic)	covalent	metallic
p. Forms when atoms share electrons	ionic	(covalent)	metallic

2. A positively charged ion is called a(n) Cation.

3. A negatively charged atom is called a(n) Anion.

4. If an element has 6 valence electrons what charge will it likely form? −2

5. If an element has 2 valence electrons what charge will it likely form? +2

6. List the 7 diatomic elements. H O F Br I N Cl

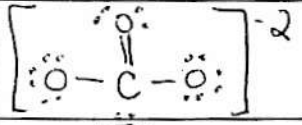
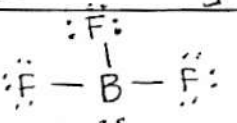
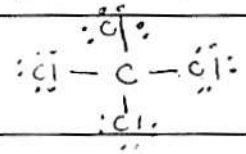
7. Identify the intermolecular forces in the following. Circle the substance with the highest boiling point

a. H_2O Hydrogen bond; H-F, O, N

b. PF_3 dipole-dipole (polar)

c. CH_4 London dispersion (non-polar)

8. Fill in the chart below:

Compound	Valence Electrons	Lewis Structure	# Bonded Atoms	# Lone Pairs	Molecular Shape	Polar/Non polar
H_2O $2(1)+6=8$	8		2	2	Bent	Polar
CO_3^{-2} $4+3(6)+2=$ $4+18+2=24$	24		3	0	trigonal planar	non Polar
BF_3 $3+3(7)$ 24	24		3	0	trigonal Planar	non-polar
CCl_4 $4+4(7)=$	32		4	0	tetra-hedral	non Polar

9. Write the name for the following:

a. NaBr Sodium Bromide

b. $FeBr_2$ Iron (II) Bromide

c. SnO_2 Tin (IV) oxide

d. N_2S dinitrogen monosulfide

e. PH_3 Phosphorus trihydride

f. P_2Br_4 diPhosphorus tetrabromide

g. $HClO_3$ Chloric acid

h. H_2SO_3 Sulfurous acid

10. Write the formula for the following:

a. magnesium acetate $Mg(C_2H_3O_2)_2$

b. nickel (III) nitrate $Ni(NO_3)_3$

c. lead (IV) sulfate $Pb(SO_4)_2$

d. dinitrogen trioxide N_2O_3

e. phosphorus pentafluoride PF_5

f. sulfur dibromide SBr_2

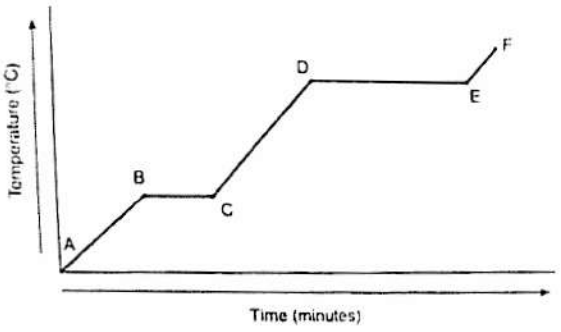
g. phosphoric acid HPO_4

h. nitric acid HNO_3

...iors Chemistry Exam Review #3 Name: NICKSIC

...Essential Standard 2.1: Understand the relationship among pressure, temperature, volume, and phase.

1. Identify the following on the heating curve below:



Solid: AB

melting: BC

Liquid: CD

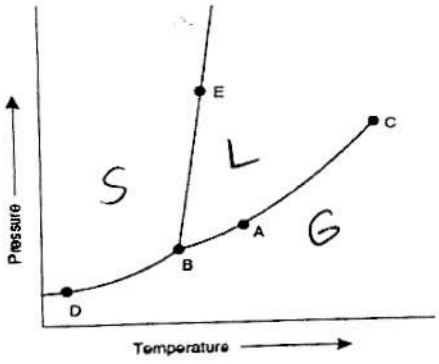
Condensation: DE

Vapor: EF

Which regions represent changes in kinetic energy? AB, CD, EF

Which regions represent changes in potential energy? BC, DE

2. Identify the following on the phase diagram below



Sublimation: D

Melting: E

Boiling: A

Triple point: B

Critical point: C

Label the diagram to show where solid (S), liquid (L), and gas (G) phases are located.

3. Calculate the mass of aluminum that would increase its temperature from 30.0°C to 40.0°C when 2500J of energy are absorbed.

$Q = mc\Delta T$ $\quad \frac{2500}{(0.897)(10)} = \frac{m(0.897)(10^\circ C)}{(0.897)(10^\circ C)}$

$280g = m$

4. How many grams of ice can be melted if 3500J of energy are absorbed?

$Q = mH_f$ $\quad \frac{3500J}{334J/g} = \frac{m(334J/g)}{334J/g}$

$10.\ g = m$

$-q_m = q_w$

5. A piece of metal with a mass of 4.68g decreases its temperature from 90.0°C to 30.0°C when placed in 25.0g of water at 25.0°C, what is the specific heat?

$q_w = 25(4.18)(5) = 523$

$-523 = 4.68g(c)(-60)$

$c = 1.86\ J/g°C$

6. How many moles of argon occupy 3.40L at 1.2atm and 25.0°C?

$PV = nRT$

$(1.2atm)(3.40L) = n(0.0821)(298)$

$25.0 + 273 = 298K$

$n = 0.17\ mol$

7. If there are 5.6 liters of gas in a piston at a pressure of 1.5 atm and compress the gas until its volume is 4.8 L, what will the new pressure inside the piston be? $P_1V_1 = P_2V_2$

$(1.5atm)(5.6L) = P_2(4.8L)$

$P_2 = 1.8atm$

8. Calcium carbonate decomposes at 1200° C to form carbon dioxide and calcium oxide. If 25 liters of carbon dioxide are collected at 1200° C, what will the volume of this gas be after it cools to 25° C? $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$\frac{25L}{1473K} = \frac{V_2}{298K}$ $V_2 = 5.1L$

$1200°C + 273 = 1473$

$25°C + 273 = 298$

9. A toy balloon has an internal pressure of 1.05 atm and a volume of 5.0 L. If the temperature where the balloon is released is 20° C, what will happen to the volume when the balloon rises to an altitude where the pressure is 0.65 atm and the temperature is -15° C? $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$\frac{(5.0L)(1.05atm)}{293K} = \frac{V_2(0.65atm)}{258K}$

$V_2 = 7.1L$

10. Two flasks are connected with a stopcock. The first flask has a volume of 5 liters and contains nitrogen gas at a pressure of 0.75 atm. The second flask has a volume of 8 L and contains oxygen gas at a pressure of 1.25 atm. When the stopcock between the flasks is opened and the gases are free to mix, what will the pressure be in the resulting mixture?

$(0.75atm)(5L) = P(13L)$

$P = 0.288\ atm$

$P = 0.3\ atm$

$(1.25)(8L) = P(13L)$

$P = 0.769\ atm$

$P = 0.8\ atm$

$P = 0.3atm + 0.8atm = 1.1\ atm$

11. Put the following gases in increasing rate of diffusion: nitrogen, fluorine, oxygen, argon, hydrogen

Ar, F_2, O_2, N_2, H_2

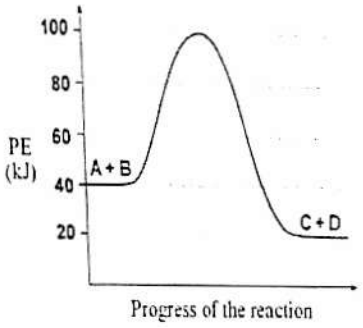
39.95 g/mol, 38g/mol, 32 g/mol, 28 g/mol, 2 g/mol

...iors Chemistry Exam Review #4 Name: Nicksic

Essential Standard 2.2: Analyze chemical reactions in terms of quantities, product formation, and energy

1. In order for molecules to react they must Collide with enough energy and in the correct Orientation.

Use the diagrams below to answer questions 2-5



2. Is this potential energy diagram, endothermic or exothermic? exothermic
3. What is the energy of the activated complex? 100 KJ
4. What is the energy of the reaction (ΔH)? -20 KJ
5. What is the activation energy? 60 KJ
6. The sign of ΔH is positive for endothermic reactions and negative for exothermic reactions.

7. List 5 indicators that a chemical reaction has occurred.
- gas produced
- precipitate produced
- color change
- heat change
- Light produced

8. Identify the type of reaction, predict the products, and balance the following:

a. $4\ Na + \_\_ O_2 \rightarrow 2\ Na_2O$ Type: Synthesis

b. $2\ NH_3 \rightarrow N_2 + 3H_2$ Type: decomposition

c. $4\ C_5H_9O + 27\ O_2 \rightarrow 20\ CO_2 + 18H_2O$ Type: combustion

d. $3\ Mg + 2\ H_3PO_4 \rightarrow Mg_3(PO_4)_2 + 3H_2$ Type: Single replacement

e. $\_\_ Li_3N + 3\ NH_4NO_3 \rightarrow 3\ LiNO_3 + (NH_4)_3N$ Type: double replacement

9. If you start with 4.5×10^{22} molecules of ethylene (C_2H_4), how many liters of carbon dioxide will be produced at STP? $C_2H_4 + 3\ O_2 \rightarrow 2\ CO_2 + 2\ H_2O$

$$\frac{4.5\times10^{22}\ \text{molecules}}{6.02\times10^{23}\ \text{molecules}} \cdot \frac{1\ \text{mol}\ C_2H_4}{1\ \text{mol}\ C_2H_4} \cdot \frac{2\ \text{mol}\ CO_2}{1\ \text{mol}\ C_2H_4} \cdot \frac{22.4\ \text{L}\ CO_2}{1\ \text{mol}\ CO_2} = 3.3\ \text{L}\ CO_2$$

10. If you start with 5.5 grams of sodium fluoride, how many grams of magnesium fluoride will be pro

$Mg + 2\ NaF \rightarrow MgF_2 + 2\ Na$

$$5.5g\ NaF \left|\frac{1mol\ NaF}{41.99g\ NaF}\right| \frac{1mol\ MgF_2}{2mol\ NaF} \left|\frac{62.31g\ MgF_2}{1mol\ MgF_2}\right| = \boxed{4.1g\ MgF_2}$$

11. What is the empirical formula for a compound which contains 0.0134 g of iron, 0.00769 g of sulfur and 0.0115 g of oxygen?

$$0.0134g\ Fe \left|\frac{1mol\ Fe}{55.85g}\right| = \frac{2.4\times10^{-4}}{2.4\times10^{-4}} = 1 \qquad 0.0115g\ O \left|\frac{1mol\ O}{16g}\right| = \frac{7.18\times10^{-4}}{2.4\times10^{-4}} = 3$$

$$0.00769g\ S \left|\frac{1mol\ S}{32.1g\ S}\right| = \frac{2.4\times10^{-4}}{2.4\times10^{-4}} = 1 \qquad \boxed{FeSO_3}$$

12. Find the molecular formula of a compound with an empirical formula of C_2OH_4 and a molar mass of 88 grams per mole.

$$\frac{88g}{44g} = 2 \qquad 2(C_2OH_4) \qquad \boxed{C_4O_2H_8}$$

13. What is the percent of oxygen in potassium carbonate? K_2CO_3

$$\frac{48.0g}{138.21g} \times 100 = \quad \%$$

14. A 15.00 gram sample of a sodium sulfate hydrate was found to contain 7.05 grams of water.

a. Calculate the percent of water in the hydrate. Na_2SO_4

$$\frac{7.05g}{15.00g} \times 100 = \boxed{47\%}$$

b. Determine the formula of the hydrate & name it.

15.00g sample
- 7.05g H_2O
7.95g Na_2SO_4

$$7.95g\ Na_2SO_4 \left|\frac{1mol}{142.05g}\right| = \frac{0.05600}{0.05600} = 1$$

$$7.05g\ H_2O \left|\frac{1mol\ H_2O}{18g}\right| = \frac{0.391}{0.05600} = 7$$

$$\boxed{Na_2SO_4 \cdot 7\ H_2O}$$

Sodium sulfate heptahydrate

Honors Chemistry Exam Review #5 Name: NICKSIC

Essential Standard 3.2: Understand solutions and the solution process.

1. Identify the following as either an acid, a base, both.

a. H_2SO_4	(Acid)	Base	Both
b. $Ca(OH)_2$	Acid	(Base)	Both
c. Conducts electricity.	Acid	Base	(Both)
d. Tastes sour.	(Acid)	Base	Both
e. Turns red litmus paper blue.	Acid	(Base)	Both
f. Has a pH greater than 7.	Acid	(Base)	Both
g. Turns phenolphthalein pink.	Acid	(Base)	Both
h. Reacts with metals to produce hydrogen gas.	(Acid)	Base	Both

2. Why are strong acids and bases considered "strong"?

completely ionize (break apart into ions)

3. Calculate the pH for the following:

(a.) pOH = 11.20 2.80

(b.) $[H^+] = 1x10^{-5}M$ 5.0

c. $[OH^-] = 1x10^{-3}M$ 11.0

d. Circle the acidic solutions.

4. Calculate the molarity of a solution made by dissolving 5.60mol of HCl in 4.5L of water.

$$M = \frac{5.60\,mol}{4.5\,L} = \boxed{1.2\,M}$$

5. Calculate the molarity of 200.0 mL of a HCl solution made by diluting a 50.0 mL of a 6.0M HCl solution.

$M_1V_1 = M_2V_2$ $(6.0M)(50.0mL) = M(200.0mL)$

$\boxed{M = 1.5M}$

6. What is the concentration of sodium hydroxide, if 34.50mL of 3.0M hydrochloric acid was needed to neutralize 35.0mL of sodium hydroxide?

$n_aM_aV_a = n_BM_BV_B$

$(1)(3.0M)(34.5mL) = (1)(M)(35.0mL)$

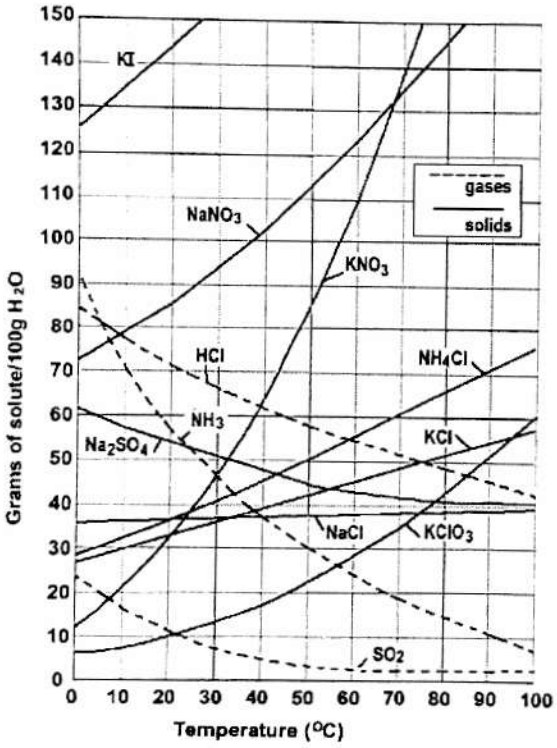
$\boxed{M = 3.0M}$

7. Fill in the blank with the appropriate term. A vocabulary word's first letter is written for you!

A H Omogeneous mixture looks uniform throughout whereas in a H eterogeneous mixtur you can see the different parts. A solution is created when a S olute is dissolved by a S olvent. Only S oluble substances can dissolve, if it cannot we call it I nsoluble. Remember that like dissolves like! When we dissolve a solute in a solvent the freezing point D epresses and boiling point E levates. These are C olligative properties.

8. To increase solubility of a solid I can increase temperature, stir (agitate), and increase surface area.

Use the graph below to answer questions:



9. Which solid is least soluble at 10°C? $KClO_3$

10. Which gas is most soluble at 90°C? HCl

11. How many grams of potassium nitrate will dissolve at 50°C? 85g

Identify the following as unsaturated, saturated or supersaturated:

12. 55g of sodium nitrate is dissolved in 100g of water at 30°C. unsaturated

13. 70g of NH_3 are dissolved in 100g of water at 10°C Saturated

14. 10g of sulfur dioxide are dissolved in 100g of water at 50°C. Supersaturated

15. As the temperature increases the solubility of a solid increases.

16. As the temperature increases the solubility of a gas decreases.

...tors Chemistry Exam Review #6 Name: Nicksic

...ential Standard 3.1: Understand the factors affecting rate of reaction and chemical equilibrium.

1. The more effective collisions that occur the faster the reaction will go.

2. What are the 3 factors that affect the number of collisions?
   - temperature
   - concentration
   - surface area

3. How does increasing the surface area increase the number of collisions?
   More spaces available to collide

4. What affect does a catalyst have on the rate of the reaction?
   increase the rate of reaction by lowering the activation energy

5. What is the difference between equal rates and equal concentrations?
   equal rates - Forward & Reverse occur @ same rate
   equal concentration - products & reactants have the same concentration

6. What occurs when a reaction reaches equilibrium?
   Forward & Reverse reactions occur at the same rate (appears nothing is happening)

7. $SO_3(g) + H_2O(g) \rightleftarrows H_2SO_4(l)$
   At equilibrium $[SO_3] = 0.400M$ $[H_2O] = 0.480M$ $[H_2SO_4] = 0.600M$

   a. Calculate the value of the equilibrium constant. *do not include solids & liquids

   $K_{eq} = \frac{1}{[SO_3][H_2O]}$ $K_{eq} = \frac{1}{(0.4)(0.480)} = \boxed{5.21}$

   b. Is the forward or reverse reaction favored?

   Forward $K > 1$

8. Consider the following equilibrium system in a closed container:

$$Ni(s) + 4\,CO(g) \rightleftharpoons Ni(CO)4(g) \qquad \Delta H = -161\ kJ$$

In which direction will the equilibrium shift in response to each change, and what will be the effect on the indicated quantity?

	Change	Direction of Shift (left, right, or *no change*)	Effect on Quantity	Effect (increase, decrease, or *no change*)
(a)	add Ni(s)	—	Ni(CO)4(g)	—
(b)	raise temperature	←	K	—
(c)	add CO(g)	→	amount of Ni(s)	↓
(d)	remove Ni(CO)4(g)	→	CO(g)	↓
(e)	decrease in volume	→	Ni(CO)4(g)	↑
(f)	lower temperature	→	CO(g)	↓
(g)	remove CO(g)	←	K	—

Honors Chemistry Exam Review #7 Name: Nicksic

Essential Standard 1.1: Analyze the Structure of Atoms & Ions

1. What subatomic particle has a charge and is found in the nucleus of the atom? proton

2. What subatomic particle has a charge and is found outside of the nucleus of the atom? electron

3. What subatomic particle has no charge and is found the nucleus of the atom? neutron

4. Write the isotopic symbol for an element that has 17 protons, 18 electrons, 18 neutrons $^{35}_{17}Cl^{-1}$

5. Calculate the average atomic mass of bromine. One isotope of bromine has an atomic mass of 78.92amu and a relative abundance of 50.69%. The other major isotope of bromine has an atomic mass of 80.92amu and a relative abundance of 49.31%.

$78.92(.5069) + 80.92(0.4931) = \boxed{79.91\ amu}$

6. Using the Bohr Diagram in your reference packet, answer the following questions.

a. What is the wavelength of light emitted when an electron moves from n=3 to n=1? 103nm

b. What is the type of light emitted? UV

c. Calculate the frequency of the emitted light.

$3 \times 10^8 \frac{m}{s} = (1.03 \times 10^{-7} m)\nu$ $\quad \nu = 2.91 \times 10^{15}\ Hz$

d. Calculate the energy of the emitted light.

$E = (6.626 \times 10^{-34})(2.91 \times 10^{15}\ Hz)$ $\quad 1.93 \times 10^{-18}\ J$

7. When electrons absorb energy they become excited and move to a higher energy level: When electrons release energy they become relaxed and move to a lower energy level.

8. Wavelength and frequency are inversely proportional. Energy and frequency are directly proportional. Therefore energy and wavelength are _ .. ___ proportional.

9. Write complete electron configurations for the following:

a. O $1s^2 2s^2 2p^4$

b. Fe $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$

c. Ca^{+2} $1s^2 2s^2 2p^6 3s^2 3p^6$

d. P^{-3} $1s^2 2s^2 2p^6 3s^2 3p^6$

10. Write noble gas configurations for the following:

a. Cs $[Xe]6s^1$ b. Br $[Ar]4s^2 3d^{10} 4p^5$

11. Complete the following reactions.

a. $^{234}_{92}U \rightarrow {}^{4}_{2}He + {}^{230}_{90}Th$ b. $^{18}_{8}O + {}^{0}_{-1}e \rightarrow {}^{17}_{7}N + {}^{1}_{0}n$ c. $^{14}_{6}C \rightarrow {}^{0}_{-1}e + {}^{14}_{7}N$

12. Determine the half life of a radioactive isotope that decays from 100.0mg to 44.3mg in 24.0 hours.

$\frac{44.3}{100} = \frac{100(0.5)^n}{100}$

$\frac{\log 0.443}{\log 0.5} = n \frac{\log 0.5}{\log 0.5}$

$n = 1.17$

$t_{1/2} = \frac{24.0}{1.17} = 20.4 \text{ hrs}$

13. How much of a 25.0g sample of $^{14}_{6}C$ remains after 100,000 years? The half life of $^{14}_{6}C$ is 5730 years?

$\frac{100,000}{5730} = 17.45$

$A = \frac{25}{2^{(17.45)}}$

$A = 1.39 \times 10^{-4} g$

14. How many grams were originally present in a sample that decays to 5.0g in 55.3 hours if the half life is 2.(days?

$\frac{55.3}{48} = 1.15$

$A = \frac{A_0}{2^n}$ $(2^{1.15})5.0 = \frac{A_0}{2^{1.15}}(2^{1.15})$

$A_0 = 11 g$

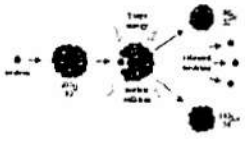
15. Identify the following as either fission or fusion.

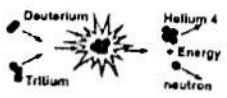
a. Occurs in the stars like the Sun — Fusion

b. Used to generate energy we use in our homes. — fission

c. Combining two small nuclei to form a larger nucleus. — fusion

d. Splits a large nucleus into smaller nuclei. — fission

e.  — fission

f. 

— fusion